The Aurora activities in the South Pole for 15 years

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Introduction

- Coronal mass ejections are large explosions of plasma and magnetic fields from the Sun's corona. When those explosions arrive at the Earth's magnetosphere, these phenomena are known as geomagnetic storms, which can cause large scale damage to facilities on the Earth. The dynamic of the aurora is one of the ways that the upper atmosphere responds to geomagnetic storms.
- The all-sky imager at the South Pole has been using the same optical system since 2006, which allows us to track the aurora activities at the same site for one full 11-year solar cycle. The imager is equipped with a filter that has two narrow 4nm wide passbands at 427.8 nm (blue line) and 630 nm (red line). Due to the location, the camera is capable of viewing the aurora 24 hours a day in the Southern winter for 3 months (May-July).
- In this work, we compare observations of the sun's 11 year cycle and the aurora activity to find the correlation of the solar wind and the aurora. To analyze the observation data from 2006 to 2021, we first quantify the degradation of the instrument over the years from the dark images to have non-biased data.
- The main scientific objectives are to examine the relation between the solar cycle and 1) the equatorward expansion of the auroral oval in the day time, and 2) the progression of the poleward boundary in the night time. Moving forward we will track the blue line and red line data to expand our understanding of the variation of the high and low energy electron precipitation in a solar cycle.

Data & Methodology

- Near the southern geographic pole it is possible to view the aurora 24 hours a day in the Southern winter for 3 months.
- Geomagnetic pole is the intersection of the meridional lines and the magnetic longitude and latitude lines.
- We receive about 4000 fit.files per day and you can retrieve an image from each fit.file hour/minutes/seconds

Fig. 1

= Magnetic Longitude and Latitude

..... = Geographic Longitude and Latitude

- We flip and rotate to point the image towards the magnetic pole.
- We use the red light as an example to make the daily keogram(white line)

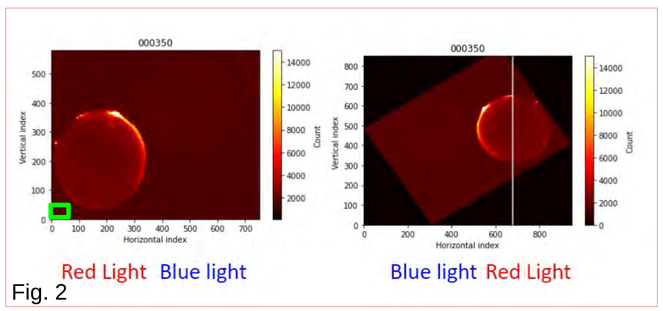

Fig. 2

Background noise analysis

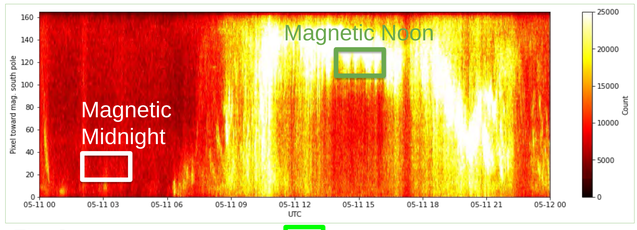

Fig. 3

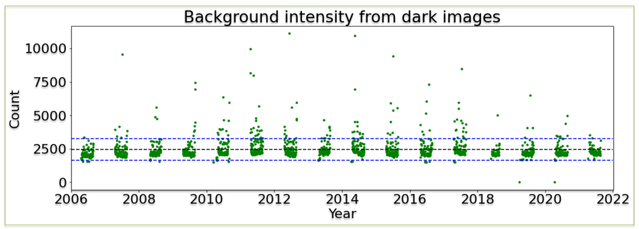

Fig. 5

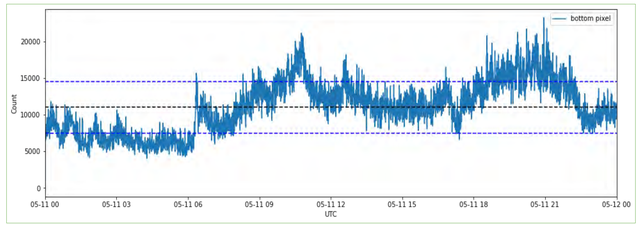

Fig. 4

- To identify the noise we use the bottom pixel of the keogram to try to identity the noise level.
- Fig. 4 shows in influence of aurora activity so that the bottom pixel in the keogram is not ideal to quantify the noise level.
- Alternatively we took a sample of the dark image at the corner of the CCD, we can conclude that the all-sky imager is not degrading significantly.
- After analyzing the all-sky imager we can start analyzing the data of the aurora activity.

Results

- The magnetic noon and midnight are correlated with each since the stronger the solar wind it opens more magnetic field lines on both sides.
- Taking ratio of the red and blue line we can also see a clear correspondence with the solar 11-year cycle.
- As the solar wind opens more magnetic field lines the location of the magnetic oval will change.
- There is more energetic particles entering the Earth when the sun is in its active years

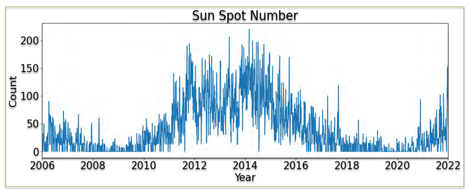

Fig. 6

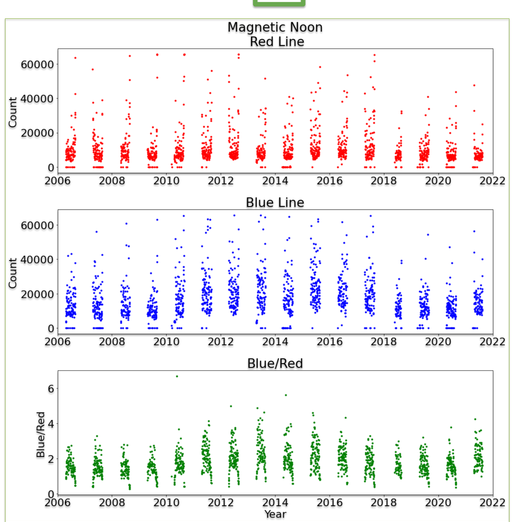

Fig. 7

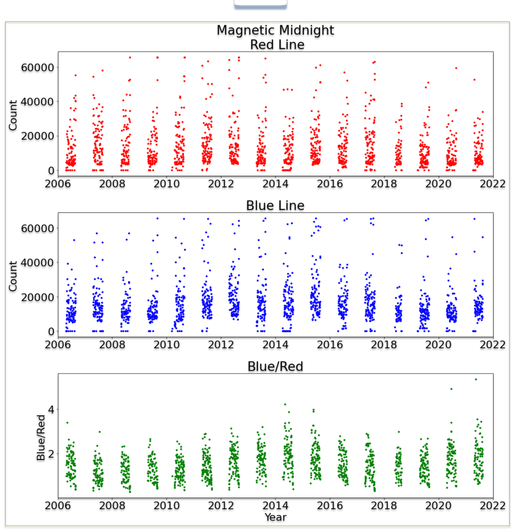

Fig. 8

Future Work

- Analyze the dynamic activities in a shorter time scale of the auroras.
- Find the relation of aurora in different colors with solar wind indexes from OMNI database.

Conclusion

- The sunspots number correlates with the aurora activity here on Earth in the 11-year solar cycle.
- The all-sky imager in the 15-year period does not show any significant degradation.

References

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Alternate Text

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'The Aurora activities in the South Pole for 15 years'

Introduction: In this work, we compare observations of the sun's 11-year cycle and the aurora activity to find the correlation of the solar wind and the aurora. To analyze the observation data from 2006 to 2021, we first quantify the degradation of the instrument over the years from the dark images to have non-biased data.
The main scientific objectives are to examine the relation between the solar cycle and 1) the equatorward expansion of the auroral oval in the day time, and 2) the progression of the poleward boundary in the night time. Moving forward we will track the blue line and red line data to expand our understanding of the variation of the high and low energy electron precipitation in a solar cycle.

Data and Methodology: Near the southern geographic pole it is possible to view the aurora 24 hours a day in the Southern winter for 3 months. Geomagnetic pole is the intersection of the meridional lines and the magnetic longitude and latitude lines. We receive about 4000 fit.files per day and you can retrieve an image from each fit.file hour/minutes/seconds. We flip and rotate to point the image towards the magnetic pole. We use the red light as an example to make the daily keogram (white line)

Figures 1 & 2, relate to data and methodology.

Background Noise Analysis: To identify the noise we use the bottom pixel of the keogram to try to identity the noise level. Fig. 4 shows in influence of aurora activity so that the bottom pixel in the keogram is not ideal to quantify the noise level. Alternatively, we took a sample of the dark image at the corner of the CCD, we can conclude that the all-sky imager is not degrading significantly. After analyzing the all-sky imager we can start analyzing the data of the aurora activity.

Figures 3, 4, & 5, are different charts or graphs that relate to background noise analysis.

Results: The magnetic noon and midnight are correlated with each since the stronger the solar wind it opens more magnetic field lines on both sides. Taking ratio of the red and blue line we can also see a clear correspondence with the solar 11-year cycle. As the solar wind opens more magnetic field lines the location of the magnetic oval will change. There is more energetic particles entering the Earth when the sun is in its active years.

Figures 6, 7, & 8, are different graphs and charts that relate to the results of the research.

Future Work: Analyze the dynamic activities in a shorter time scale of the auroras. Find the relation of aurora in different colors with solar wind indexes from OMNI database.

Conclusion: The sunspots number correlates with the aurora activity here on Earth in the 11-year solar cycle. The all-sky imager in the 15-year period does not show any significant degradation.

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